HURLEY DOC. #16

Chino Mines Company
Hurley, New Mexico

Administrative Order on Consent
Remedial Investigation, Sampling Plan for Garden Vegetables, Hurley Soils Investigation Unit

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9404534

INTRODUCTION

This proposal provides the plan for collection of garden plant samples in the town of Hurley, New Mexico. The garden vegetable collection activity is one of several identified for the Hurley Soils Investigation Unit (HSIU).

1. OBJECTIVE

A human health risk assessment was conducted for the HSIU using data collected in the Phase I and Phase II RIs. The risk assessment included an evaluation of risk from the ingestion of homegrown garden plants. The evaluation used several conservative default parameters to estimate the potential risk associated with the ingestion of homegrown plants in Hurley.

This proposal provides the sampling plan for the collection of garden vegetables in Hurley in support of the human health risk assessment evaluation of the vegetable ingestion pathway. The objective of this investigation is to provide arsenic data from homegrown garden vegetables in Hurley to replace the plant concentrations modeled from garden soil data that were used in the human health risk assessment. In addition, site-specific intake information will be collected for consideration in the evaluation of the quantity of homegrown plants ingested in Hurley.

Plant metal concentrations were developed in the risk assessment using garden soil sample data and a conservative soil-to-plant uptake model to calculate the metals concentrations in the garden vegetables. However, as described in the risk assessment, the uptake of metals from soil to plants can vary by several orders of magnitude due to variations in soil type, organic content of the soil, metals species, metals concentrations, pH, and the type of plant, among other factors. The use of modeled metal concentrations provided a significant source of uncertainty in the risk assessment (Gradient 2000). It was recommended by Gradient that data be collected from actual garden vegetables in Hurley to reduce the uncertainty associated with this exposure pathway.

The EPA conservative default parameters for the ingestion of homegrown plants were used in the development of the ingestion rate for homegrown plants. The town of Hurley is located in an arid region with mostly inorganic soil types. Gardens in this region need additional organic material and/or other amendments, and extensive watering in order to be viable. Gardens observed in Hurley are typically small (i.e., an average of less than 300 square feet), and thus do not provide large volumes of edible plants. Since there is such extra effort required to produce a garden in this region, it is likely that the intake of homegrown plants from gardens in Hurley is lower than the conservative default values used in the risk assessment (which were taken from an eleven state region). Site-specific data will be collected during this investigation in order to refine the conservative default values used in the risk assessment.

2. BACKGROUND

As described above, the human health risk assessment evaluated the ingestion of homegrown garden vegetables as one of the exposure pathways for the HSIU. Arsenic is the only carcinogen identified in Hurley garden soil, and therefore the cancer risk estimates in this pathway are 100% attributable to arsenic.

A garden survey was conducted as part of the Phase I RI in Hurley. A total of 30 vegetable gardens were identified in the town of Hurley. There are about 550 residences in the town of Hurley (Golder 1998) which equates to approximately 5% of the homes in Hurley having a garden. A total of 13 of the observed gardens are located within the easternmost two blocks of Hurley (where relatively higher concentrations are expected to occur). A total of 10 gardens in the easternmost two blocks were randomly selected for soil sample collection as part of the Phase I RI.

Composite soil samples were collected from the root zone in each selected garden and analyzed for the investigation constituents. The mean and the upper 95th percentile metals concentrations from these 10 samples were used in the risk assessment to represent the central tendency and the high-end garden soil concentrations, respectively. Table 1 provides a summary of the arsenic data from Hurley garden soil samples compared to arsenic in reference soil samples collected from the area to the west of Hurley. As can be observed from the table, the mean arsenic concentrations in garden soil do not differ significantly from reference soil, however, the maximum arsenic concentration observed in garden soil is higher than the maximum reference soil concentration, which elevates the 95th percentile estimate for garden soil arsenic.

As described in the human health risk assessment, garden soil concentrations for arsenic were converted to modeled plant concentrations using the Bechtel regression model (Gradient 2000). The Bechtel model was derived based on the uptake of metals into foliage and stems of plants, which is typically greater than uptake into fruits, seeds, or roots of plants. The plants grown in Hurley for human consumption are typically fruits, seeds, or roots, as described in the Phase I RI Report (Golder 1998). The leaves and stems of these plants are generally not consumed. Therefore, as stated in the risk assessment, the use of the Bechtel regression model based on foliage and stems likely overestimates the concentrations of metals in the types of vegetables typically grown in Hurley. The modeled arsenic concentrations for plants in Hurley are 0.27 mg/kg and 0.41 mg/kg for the central tendency and high-end estimates, respectively.

The total cancer risk for garden vegetable ingestion was calculated for children and adults using both the central tendency and the high-end estimates (Gradient 2000). The excess cancer risk posed by site contaminants deemed unacceptable by the Environmental Protection Agency (EPA) is generally within a target range of 10^{-6} to 10^{-4}. The results of the risk assessment for garden

vegetable ingestion exceeded the bottom end of the target risk range, as shown in the Table 2. The high end adult risk estimate (1.3E-04) is slightly higher than the upper limit of the target risk range.

3. SCOPE OF WORK

Garden vegetables will be collected in September 2000 in order to provide site-specific arsenic concentrations in homegrown plants from Hurley gardens. These data are intended to refine the risk estimate for the ingestion of garden vegetables by replacing the modeled concentrations that were used in the absence of actual garden vegetable data.

The uptake of arsenic in plants may vary depending on several factors, including plant species, soil type, pH, organic content of the soil, and the presence and/or uptake of other metals in the soil. In order to evaluate the variations in arsenic uptake in homegrown plants, these factors will also be considered.

3.1 METHOD DETECTION LIMIT

The maximum reporting limit required by the Quality Assurance Plan (QAP) for the project is 0.43 mg/kg in a solid matrix. In order to determine whether the estimated cancer risk associated with the ingestion of arsenic in homegrown plants is at or below the target risk range (10^{-4} to 10^{-6}), it is necessary to achieve a much lower method detection limit for a solid matrix.

Using the algorithms and factors developed by Gradient for the garden vegetable pathway (Gradient 2000), the arsenic concentrations that would result in a risk estimate below the target range (i.e., 10^{-6} or less) for plant tissue were back-calculated, as presented in Table 3. Arsenic concentrations must be detectable at or below the back-calculated concentrations in order to determine whether concentrations in plant tissues are below the bottom level of the target risk range.

The arsenic concentrations in plants that would result in potential risk at the bottom limit of the target risk range (10^{-6}) in a high end child scenario is 0.013 mg/kg. This level is an order of magnitude below the maximum reporting limit required by the QAP for arsenic analyses in a solid matrix. The laboratory selected for this investigation (ACZ Laboratories Inc) can achieve a method detection limit of 0.03 mg/kg using ICP/MS analysis. The detection limit may be further lowered using selected ion monitoring (SIM), where the analytical instrument looks at a sample for up to ten times longer per analyte than under the standard method. However, the actual detection limit using this technique is not known, and will not be determined until the samples are analyzed.

For the high end adult risk estimate, it would be necessary to achieve a method detection limit of 0.003 mg/kg in a solid matrix in order to determine whether a plant arsenic concentration would result in a potential risk estimate below the bottom limit of the target risk range (10^{-6}). This level is two orders of magnitude below the maximum reporting limit required by the Quality

Assurance Plan for the project, and one order of magnitude below the method detection limit that the laboratory can achieve using ICP/MS. It may not be technically feasible to achieve this detection limit. However using the attainable detection limit of 0.03 mg/kg, it will be possible to determine whether plant concentrations are within or above the acceptable target risk range between 10^{-4} and 10^{-6}.

3.2 GARDEN SAMPLING PLAN

A total of five gardens will be sampled for this study. The gardens sampled for this investigation will be a subset of the ten gardens sampled for the Phase I RI. The gardens located at stations V-07, V-09, V-04, V-06, and V-12, as identified in Figure 1, have been selected for sampling. These gardens represent the minimum, 25th percentile, 50th percentile, 75th percentile, and the maximum arsenic concentrations observed in garden soil per the Phase I RI. If any of these gardens are not suitable for sampling, then an alternative garden within the set of ten gardens used in the Phase I RI will be sampled. A garden will be determined unsuitable for sampling if any of the following conditions arise:

- The garden is not active (i.e. have a crop growing this year);
- There are less than two types of edible plants growing this year;
- There is insufficient material to collect for analysis;
- The property owner does not grant access to the property and/or the garden.

At each garden, the field team will record the types of consumable plants growing at the time. The consumable part of the plants will be categorized (e.g., fruit, seed, root, leaf). Corn crops will be considered as a fruit for this study. A maximum of three plant categories will be sampled at each garden. If there are more than one type of plant per category (i.e., three types of fruits such as tomatoes, chilies, and squash), then samples will be collected from up to two different types of plants per category. Three samples will be collected from each type of plant sampled, and they will be composited into one sample. Thus, a minimum of two and a maximum of six composite samples will be collected at each garden for a total number of samples ranging between 10 and 30 composite samples.

The sample volume collected will depend upon the type of plant and the estimated moisture content of the plant. The laboratory requires about 2 grams dry weight per sample for analysis. The field sampler will determine the quantity of plants needed to meet that objective. For example, a tomato is comprised of a higher percentage of water relative to a carrot, therefore more tomatoes may be required relative to the number of carrots required.

The samplers will wear a new pair of disposable latex gloves for each garden. The consumable portion of the plant will be picked and rinsed in deionized water to remove soil. The sample will be wiped off with a clean paper towel and placed in a sealable plastic bag. Samples will be shipped under chain of custody at 4 degrees C to ACZ laboratory.

For reference purposes, an additional two samples will be collected for each plant type collected in the field. One set of reference samples will be collected from two different grocery stores in Silver City, NM. These plants will be handled, shipped and analyzed in the same manner as the Hurley garden samples.

The plant samples will be sent to ACZ laboratory for Phase I investigation constituents analysis. The investigation constituents are listed in Table 4. The arsenic concentration will be measured by ICP/MS with a minimum reporting limit of 0.03 mg/kg on a dry weight basis. The moisture content will be calculated from the wet weight measured in the laboratory upon receipt of the sample.

TABLE 4
PHASE I INVESTIGATION CONSTITUENTS

Parameter	Units	Reporting Limit
Arsenic	Mg/kg	.030
Barium	Mg/kg	0.3
Cadmium	Mg/kg	0.01
Cobalt	Mg/kg	0.005
Copper	Mg/kg	0.05
Lead	Mg/kg	0.01
Manganese	Mg/kg	0.5
Molybdenum	Mg/kg	1.0
Selenium	Mg/kg	0.1
Silver	Mg/kg	0.005
Zinc	Mg/kg	0.2

A soil sample will be collected at the root zone near each plant sampled. The root zone will be determined in the field for each plant type by excavating and observing the depth of roots. The soil samples will be composited for each plant type. The soil samples will be sent to SVL for pH, total arsenic analysis and total organic content. The results of the soil analysis will be compared to the arsenic concentrations observed in the plants.

3.3 GARDEN USE SURVEY

The resident of each of the properties visited (preferably the gardener) will be interviewed at the time of sampling using the questionnaire inlcuded in Appendix A. Estimates of the quantity of edible plants grown and consumed will be collected. The field team will attempt to obtain specific brand names of fertilizers or soil additives used, if possible.

4. SCHEDULE

The garden vegetable sampling may take place within one week of approval of the sampling plan. Since the harvest of homegrown vegetables is time-critical, this sample collection event will likely occur no later than mid-September 2000.

The gardens to be sampled will be selected at least one week prior to sampling. The owners will be contacted and requested to sign an access agreement form. If access is denied, another garden will be randomly selected. The granting of access will likely commence prior to approval from NMED in the interest of time. Sample collection will take approximately one or two days.

The analytical results will likely be available three weeks after the samples are received at the laboratory. The data will be validated within two weeks of receipt. A preliminary report will be prepared and submitted to NMED and Gradient within four weeks of receipt of the analytical data from the laboratory.

TABLE 1
ARSENIC ANALYTICAL RESULTS
FOR HURLEY GARDENS AND REFERENCE SOIL

Town of Hurley Garden Soil

Sample Location	As Result (mg/kg)	Q
V-01	4.9	J
V-02	3	J
V-04	2.8	J
V-05	2.9	J
V-06	3	J
V-07	0.95	J
V-09	8.8	J
V-11	2.4	J
V-12	3.2	J
V-13	2.7	J
STATISTICAL SUMMARY		
Number of samples	10	
Number of detected values	10	
Minimum value	0.95	J
Maximum value	8.8	J
Mean value	3.5	
Standard Deviation	2.10	
Coefficient of Variation	0.61	
25th percentile	2.8	
50th percentile	3.0	
75th percentile	3.2	
90th percentile	5.3	
95th percentile	7.0	

Reference Soil

Sample Location	As Result (mg/kg)	Q
HR-01	2.85	J
HR-02	2.93	J
R-01	3.06	
R-03	0.7	U
R-05	2.35	
R-07	2.31	
R-08	1.46	
R-12	2.71	
R-14	0.7	U
Number of samples	9	
Number of detected values	7	
Minimum value	0.7	U
Maximum value	3.1	
Mean value	2.1	
Standard Deviation	0.93	
Coefficient of Variation	0.44	
25th percentile	2.1	
50th percentile	2.4	
75th percentile	2.9	
90th percentile	3.0	
95th percentile	3.0	

J Estimated value
Q Qualifier
U Not detected, value reported is one half the detection limit for calculation purposes

09/08/2000

TABLE 2

ESTIMATED CANCER RISK FROM ARSENIC IN HOMEGROWN VEGETABLES

Factors	Abbrev	Units	Central Tendency Child	Central Tendency Adult	High End Child	High End Adult
Arsenic Concentration	Conc	mg/kg	0.27	0.27	0.41	0.41
Intake Rate	IR	g/kg-d	0.065	0.065	0.67	0.67
Exposure Frequency	EF	d/yr	350	350	350	350
Exposure Duration	ED	yr	6	9	6	24
Conversion Factor	CF	g/kg-d	1.0E-03	1.0E-03	1.0E-03	1.0E-03
Slope Factor	SF	mg/kg-d	1.5	1.5	1.5	1.5
Attenuation Factor	AT	d/yr	27375	27375	27375	27375
Estimated Cancer Risk (As)	**Risk**	**unitless**	**2.0E-06**	**3.0E-06**	**3.2E-05**	**1.3E-04**

$$\text{Estimated Cancer Risk (As)} = \frac{\text{Conc} * \text{IR} * \text{EF} * \text{ED} * \text{CF} * \text{SF}}{\text{AT}}$$

TABLE 3

ESTIMATED ARSENIC CONCENTRATIONS RESULTING IN ACCEPTABLE RISK ESTIMATES

Factors	Abbrev	Units	Central Tendency Child	Central Tendency Adult	High End Child	High End Adult
Estimated Cancer Risk	Risk		1.0E-06	1.0E-06	1.0E-06	1.0E-06
Attenuation Factor	AT	d/yr	27375	27375	27375	27375
Intake Rate	IR	g/kg-d	0.065	0.065	0.67	0.67
Exposure Frequency	EF	d/yr	350	350	350	350
Exposure Duration	ED	yr	6	9	6	24
Conversion Factor	CF	g/kg-d	1.0E-03	1.0E-03	1.0E-03	1.0E-03
Slope Factor	SF	mg/kg-d	1.5	1.5	1.5	1.5
Arsenic Concentration	**Conc**	**mg/kg**	**0.13**	**0.089**	**0.013**	**0.0032**

$$\text{Estimated Arsenic Concentration} = \frac{\text{Risk} * \text{AT}}{\text{IR} * \text{EF} * \text{ED} * \text{CF} * \text{SF}}$$